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Original Research Article

Performance of Rice in Modified Conventional System over System of Rice Intensification (SRI)

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Keywords

Weeds, Herbicides, Weed control efficiency, Cane yield and seasonal sugarcane

A B S T R A C T

A field experiment was conducted in Agronomy Main Research Farm of Odisha University of Agriculture and Technology, Bhubaneswar ($20°15'N$ latitute, $85°52'$ longitude and 25.9 m above mean sea level) in summer season of 2014 and 2015 to study the "Performance of rice in modified conventional system over system of rice intensification". Four management options; modification of planting techniques (age of seedling, number of seedling and spacing), water management (raised bed, maintain saturation), weed management (cono weeding, seedling planted at 25cm×25cm spacing) and nutrient management (nutrient supplied through FYM and Vermicompost) were assigned as 16 treatments in different combination in three replications following Randomise Block Design (RBD). SRI method recorded maximum grains per panicle (146), lowest sterility (8%) but with high cost of cultivation (Rs. 36566 per ha).When conventional system was modified with respect to water management, recorded highest grain yield (4.94 t/ha), B-C ratio (1.98), and net return (Rs 30952 per ha). Whereas, maximum harvest index (0.48) was recorded in modified weed and nutrient management practice. But when conventional system was modified with respect to planting, water and nutrients management recorded maximum straw yield (6.06 t/ha) and maximum nutrient uptake (239.85 kg/ha).

Introduction

Rice is a unique creation of crop domestication; it is unique in having cultivars of maturity duration varying from less than 80 days to more than 180 days and showing adaptability to a wide range of land situation and water regimes including condition of water stagnation while no other crop could possibly be grown. The importance and explicit role of rice to meet current food crisis is yet again challenged, as it accounts for over 20 percent of the global calorie intake providing 60-70% of body calorie intake of the consumers.

World rice production nearly doubled from the 1960s to the 1980s mainly due to the technological advancement through the green revolution. The green revolution uses excess external inputs (mineral fertilizer, irrigation water and pesticides), which increases cost of cultivation. This is more so on irrigated crops like paddy; the spectacular increase in production of paddy was restricted to irrigated belts of the country. After widespread green revolution throughout irrigated paddy field in Asia, the increase of rice yield slackened, reflected by decline in the normal rate of rice yield increase from 2.7% in the 1980s to 1.1% in the 1990s.

The targeted demand of rice for Indian population has been set at 115 million tonnes by the year 2025 (Manzanilla *et al.*, 2011). A conservation statistics indicates that about 21% extra production is to be ensured to feed the population by the year 2025 (Bhuiyan *et al.*, 2002), as there is no opportunity to increase the rice area; much have to come from higher average yield on existing, the land.

To effectively address the trilemma of productivity, environmental and natural resources, it is essential to develop and practice improved technologies that enhance crop productivity through efficient resource use in sustainable manner. This will be very effective to break the yield plateau.

"With less water, less seed, no fertilizer, no pesticide, more soil organic matter and more soil aeration, the productive potential of rice can be unleased". As a new way of looking at rice cultivation and solely driven by the innovative farmers, system of rice intensification (SRI) has emerged as an alternative to conventional water and chemical intensive cultivation (Rao,2006).Yet the SRI approach offers principles and components that could –if properly applied and integrated- permit increase yields as well as saving the external inputs for a wide range of production system, (Andrianaio and Joelibarison,1999).However reduced yields under SRI have also been reported by Mc Donald *et al.,* (2006). Keeping aside the controversies and in adequate scientific insight, the present investigation was under taken to access the contribution of each component principle towards the performance of SRI.

Materials and Methods

The field experiment was conducted in Agronomy Main Research Farm of Odisha University of Agriculture and Technology, Bhubaneswar ($20°15'N$ latitute, $85°52'$ longitude and 25.9 m above mean sea level) during summer season of 2014 and 2015. The area is characterized by hot and humid climate. Soil of the experimental site was sandy loam in texture, low in organic carbon (4.3 g kg^{-1}), medium available N (365.2 kg/ha),high in available P (46.2 kg/ha) and medium in available K(253.3 kg/ha). Rainfall of 1415.3mm was recorded in 2014 and 1585.4 mm in 2015. The mean maximum and minimum temperature during crop period was 39.2$^{\circ}C$ & 27.7$^{\circ}C$ for 2014 and 40$^{\circ}C$ &27.9$^{\circ}C$ t in or 2015 respectively. The experiment was laid out in Randomise Block Design (RBD) with 16 treatment and 3 replication with gross plot size of 15.75 m^2 and net plot size of 14.25 m^2.The rice variety Lalat was shown on 16th & 10th of Jan in 2014 & 2015 for conventional method and 29th & 23th of Jan in 2014 & 2015 for modified method, respectively which was harvested on 12th June. The conventional system (T_1) was treated as control where 21 days old seedling were transplanted at 15 $\times$10 cm spacing at the rate of 3 seedling per hill, flooded irrigation, weed were managed by application of Butachlor and hand weeding twice 15 &30 DAT, all the nutrient (N,P,K) were supplied through urea, SSP and MOP. In System Of Rice Intensification (T_{16}) all the stated principles were modified by taking 12 days old seedlings, one seedling per hill planted at 25$\times$25 cm spacing, soil kept saturated till reproductive stage and the water maintained at 2.5-3 cm level. weed were managed by incorporating weeds by cono weeder at 15,30,45& 60 DAT providing nutrient through FYM and vermicompost on N equivalent basis with split application. In rest of the treatments only one principle was modified in the line of conventional practice in four treatments i.e. (T_2)with modified planting, (T_3)with modified water management,(T_4)with modified weed management& (T_5) with modified nutrient management, only two factors modified in the line of SRI practice in rest four treatments i.e. (T_6) with modified planting and water management,(T_7) with modified planting and weed management,(T_8) with modified planting and nutrient management,(T_9) with modified water and weed management,(T_{10})with modified water and nutrient management,(T_{11}) with modified weed and water management and three factors modified in the line of SRI practice in last four treatments i.e. (T_{12}) with modified planting, water & weed management,(T13) with modified planting, water and nutrient management,(T_{14}) with modified planting, weed & nutrient management and (T_{15}) with modified water, weed and nutrient management.

Results and Discussion

Maximum total dry matter production (2807 g m^{-1}) was recorded in (T_{11}) with modified weed and water management because saturation condition must have favoured better root activity due to proper aeration resulting higher nutrition and biomass production. When three factor modified (T_{13}) with modified planting, water and nutrient management produced maximum number tiller (563), total maximum nutrient uptake (239.85 kg ha^{-1}) which was 17.5%, 17.9% higher than the conventional system and 6.9%, 11.3% higher than the SRI respectively. When single factor was modified conventional system with respective to modified water management recorded highest tillers per m2 (464), field saturation created aerobic situation which favour more tillers per hill than continues flooding and when two factor were modified conventional system with respect to modified planting method and water management recorded highest till per m^2 (524). More number of total tillers was noticed with 12 days old seedlings because younger seedling has more number of phyllochrons for massive tillering (uphoff, 2002).

Number of effective tillers per unit area is the primary attribute for obtaining good yield is function of number of ear bearing tillers per unit area. Among all the treatments highest number of effective tillers (431) per m^2 was noticed when conventional system was modified with respect to (T_3) water management which was 25% higher than conventional system 45% higher than SRI. It was even higher than the other treatment when additional factor were modified. The reason for more number of effective tillers might be due to higher leaves per m^2, higher LAI resulting in increased photosynthetic ability and dry matter accumulation as well as slow release and effective absorption of mineral nutrient due to favourable soil condition in non-flooded aerated situation because of profuse root growth.

When conventional system was modified with respect to water management (T_3) shown highest contribution to most yield attributing characters i.e. total number of grain per panicle (140) which is 22.2% higher than conventional & 26.2% higher than SRI, filled grain per panicle (128), minimum sterility (8%) which was 34% lower than conventional and 6.8% lower than SRI, highest test weight (26.9g)which was 15.4% higher than conventional & 5.4% higher than SRI and finally highest grain yield (4.94 t/ha) which was 41.9% higher than conventional and 2.06% higher than

SRI. Lowest grain yield was obtained (T_{14}) with modified planting, weed & nutrient management, the sterility percent increase with addition of factors and with modified nutrient management, sterility was highest (29%) in combination of modified planting and modified weed management. It was observed from different combination of management options that modified nutrient management reduced number of grains per panicle with high sterility percent. Insufficient nutrient supply from organic sources must have adversely affected grain filling to which the inorganically grown treatments. Profuse root growth under non flooded condition and release of nitrogen from inorganics might have helped in achieving more field grains per panicle. The increase in shoot dry matter production might have supported improvement in yield components and field grains per panicle. Better translocation permitting situations of accumulated photosynthates for grain filling might be also one of the reasons of more grains per panicle and higher test weight. Higher 1000 grain weight was observed in wider spacing than the closer spacing. Aziz and Hasan (2000) reported higher 1000 grain weight with wider spacing.

Table.1 Effect of component principles of SRI on yield attributes and yield (pooled over two years)

Treatments	Dry matter production (g m^{-2})	# Effective tiller m^{-2}	# Grains per panicle	Sterility (%)	Test Wt.(g)	Grain Yield (t ha^{-1})	Harvest index
T1 (C)	2255	334	127	233	23.3	3.48	0.37
T2 (C+F1)	2453	352	125	16	25.5	4.15	0.41
T3 (C+F2)	2514	331	140	8	26.9	4.94	0.47
T4 (C+F3)	1266	272	125	31	22.5	3.14	0.37
T5 (C+F4)	2260	342	133	22	24.2	3.81	0.41
T6 (C+F1+F2)	2316	384	137	21	26.8	3.99	0.43
T7 (C+F1+F3)	1344	341	125	29	23.5	2.90	0.35
T8 (C+F1+F4)	2469	351	123	27	24.7	3.89	0.40
T9(C+F2+F3)	1152	350	131	26	24.1	2.4	0.29
T10(C+F2+F4)	1366	381	131	22	25.2	2.91	0.33
T11(C+F3+F4)	2807	283	125	21	23	4.4	0.42
T12(C+F1+F2+F3)	1245	296	127	16	24.8	3.49	0.42
T13(C+F1+F2+F4)	2647	370	131	18	26.7	4.85	0.45
T14(C+F1+F3+F4)	1236	426	136	15	24.4	2.23	0.32
T15(C+F2+F3+F4)	1267	277	123	26	24.5	2.73	0.32
T16(C+F1+F2+F3+F4)	1391	296	124	19	25.5	4.84	0.45
SEm +	1.115	0.222	1.251	0.410	0.418	0.038	0.008
CD(0.05)	3.36	6.69	3.78	1.24	1.24	0.11	0.02

C= conventional method,F1; Modification in planting technique,F2; modification in water management,F3;modification in weed management,F4; modification in nutrient management

Table.2 Effect of Component principles on nutrient uptake and economics of rice pooled over two season

Treatments	Total Nutrient Uptake(kg ha^{-1})	Cost of Production (Rs ha^{-1})	Gross Return (Rs ha^{-1})	Net return (Rs ha^{-1})	Benifit: cost
T1 (C)	196.86	31040	43848	12808	11.41
T2 (C+F1)	210.51	28220	52290	24070	1.85
T3 (C+F2)	233.08	31292	62244	30952	1.98
T4 (C+F3)	165.39	29358	39564	10206	1.35
T5 (C+F4)	197.82	36556	48006	11450	1.31
T6 (C+F1+F2)	229.32	28472	40274	21802	1.77
T7 (C+F1+F3)	191.7	27338	36540	9202	1.34
T8 (C+F1+F4)	205.54	32936	42014	16078	1.49
T9(C+F2+F3)	201.93	30410	30240	-170	0.99
T10(C+F2+F4)	205.86	36008	36666	658	1.02
T11(C+F3+F4)	181.15	34874	55440	20566	1.8
T12(C+F1+F2+F3)	191.21	28850	43974	15124	1.52
T13(C+F1+F2+F4)	239.85	34448	61110	26662	1.77
T14(C+F1+F3+F4)	162.76	28314	28098	-216	0.99
T15(C+F2+F3+F4)	172.76	35126	34398	-728	00.98
T16(C+F1+F2+F3+F4)	213.38	33566	60984	27418	1.82

C= conventional method,F1; Modification in planting technique,F2; modification in water management,F3;modification in weed management,F4; modification in nutrient management

When conventional system modified with respect to water management (T_3) also observed highest harvest index (0.47)which was 21.3% higher than conventional and 4.4% higher than SRI and (T_{10})with modified water and nutrient management shown lowest harvest index (0.33). Maximum harvest index because of higher grain yield might have resulted due to proper availability of nutrient in all the growth stages by inorganic sources which ultimately laid to higher LAI, high dry matter accumulation, higher panicle bearing tillers per unit area and more number of filled grains per panicle. This is in conformity of findings of Roknuzzaman(1997).

In conventional system total production cost, gross return and net return was Rs 31040, Rs 43848 and Rs 12808 ha^{-1} respectively, with B-C ratio of 1.41 where as in SRI practice these were Rs 33566, Rs 60984 and Rs 29515 ha^{-1}, respectively with B-C ratio of 1.82. Maitti *et al.,* (2013) reported B-C ratio of 1.76 & 1.88 in SRI in first and second season compared to 1.3 & 1.35 in conventional practices. But in the present study when only two factors were modified with respect to planting and weed management (T_7) the minimum cost of production (Rs 27338 ha^{-1}) was obtained. But maximum gross return (Rs 62244 ha^{-1}), net return(Rs 30952 ha^{1}) and B-C ratio (1.98) was noticed in (T_3) modified water management practices. This is because of cost effective modification production process. This was treated as the best combination.

However maximum cost of production (Rs 36556 ha^{-1}) was recorded in treatment comprising of modified nutrient management because of high cost of organics than inorganic. Closer spacing recorded higher cost of production than wider spacing due to high plant population.

The present study conclude that among the different combination, modification of conventional method allowed for more returns was with respect to water management, with respect to two factors it was planting technique and water management and with respect to three factors it was planting technique, water management and nutrient management.

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